THE RESISTANCE OF *ORNITHODORUS MOUBATA* TO VARIOUS SHEEP-DIPS

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The following experiments were carried out (under the Sir Edwin Durning-Lawrence fund as stated in the previous paper) with each of the dips as described below, the preparation of the dip solution being carried out as stated in the directions on each sample.

A. Animal experiments.

1. *Prophylactic.* The skin of the animal (goats were most frequently used for the purpose of feeding the ticks) having been shaved, was soaked with the solution to be tested. While the skin was still moist the parasites were placed on it and observations made. Again, the skin was allowed to dry before the ticks were placed on it, and the effect noted.

Many experiments were done to ascertain whether the dip solution used, Cooper's, Little's, Savar's, Hayward's Yellow Paste, and MacDougall's dip, were capable of completely preventing ticks feeding on animals, either when the dip was still moist on the skin of the animal, or when it had dried. Frequently, the ticks fed well, but sometimes they refused to feed under these conditions. But as those ticks which would not feed, refused usually to do so when placed on normal skin used as a control, their failure to feed can hardly be attributed to the prophylactic action of the applications, but should more probably be attributed to the condition of the ticks themselves.

2. *Curative.* The ticks were allowed to feed on the shaved skin of an animal, and while still feeding, the various dip solutions were applied to them at varying intervals after the commencement of the meal, the dips being poured into the feeding glass, completely covering over the parasites.

When ticks of this species were permitted to attach themselves

to an animal, and the solution of dip poured over them, the results varied, not only as regards the immediate effect upon the tick, but also as regards the after effects. Generally speaking, the sooner after the commencement of the feed the application was made, the more likelihood there was of the ticks becoming loosened, and apparently also the more chance of the parasites subsequently dying. But these are points which scarcity of material prevented working out as completely as was desirable.

B. In vitro.

Ticks were placed in test tubes and the dip solutions poured over them, care being taken that the parasites were completely covered by the solution; this was effected by means of a piece of blotting paper which prevented the ticks rising to the surface of the fluid. The experiments of Group B were usually carried out until a definite effect was obtained on the ticks, either by increasing the time of application, or by increasing the strength of the solution used. Several consecutive treatment experiments were carried out with individual ticks, of which the following is an example. Using Little's dip in a strength of 1 : 50, a tick was covered over with the fluid in a tube for a period of two minutes. It was taken out, dried and warmed and was found to be alive and active. It was then subjected to the following periods of complete immersion in the solution, four minutes, eight minutes, sixteen minutes, and thirty-two minutes, being dried and warmed after each application and at once re-immersed. At the end of this series it was active. It was then rested for ten hours for observation, when a further immersion, this time for sixty-four minutes, was made; it was still alive and active, but at the end of the next period of application—a hundred and twenty minutes—it was found to be dead. Using Cooper's dip in a strength of 1 : 50 a tick survived immersion for thirty-two minutes, followed by immersion for two hundred and sixty minutes. Fuller details of experiments are given under the head of each dip. Experiments carried out as described above brought out certain very interesting facts in connection with the powers of resistance of *Ornithodorus moubata*, to various liquid preparations. It is well to draw attention here to the fact that ticks belonging to the family *Argasidae* are generally supposed to possess greater powers of

resistance than other ticks. Whether this is so or not, certainly the resistance of *Ornithodorus moubata* to the lethal action of these common sheep dips is noteworthy. If this property is the exceptional possession of ticks of this family it will naturally not diminish the value of the applications tested in their behaviour towards other ticks. At any rate, it would be of interest to have a very complete set of experiments done with other species in order to establish this point. Meanwhile, making every allowance for possible variations in other species, and admitting that fuller experiments are necessary, it appears evident that these ordinary applications fail to affect *Ornithodorus moubata* so as to kill it either with rapidity or certainty.

Cooper's dip. '*The best known means of destroying all the ticks. To kill ticks and prevent the fly striking. The best time to dip is about a month after shearing, but sheep thrive better if dipped again in the autumn, to keep them clean through the winter.*' It will be observed that here both prophylactic and curative properties are attributed to this dipping preparation. The strength recommended is about 1 to 100 parts of water, the time of application one minute.

A. Animal experiments. This dip applied to shaved skin did not completely succeed in preventing ticks feeding, either when they were placed on the animal while the skin was damp, or after the skin had dried. When applied to ticks already feeding it frequently failed to stop them or make them relax their hold. Even when applied for longer times and in much greater strength than recommended it sometimes failed to kill. For example, ticks feeding on a dog were treated fifteen minutes after the commencement of the feed with a strength of 1 : 50 for two and a half minutes. They went on feeding, and were alive and active twenty-four hours after removal.

B. In vitro. One hour's complete immersion failed to kill ticks; two hours also failed. Five hours was effective in one experiment.

Little's dip. '*A greatly improved cattle wash and sheep dip for scab, lice, ticks and all parasites. Ticks and ordinary dipping. One gallon dip to* 100 *to* 120 *gallons of water.*' The time of application recommended is one minute.

A. Animal experiments. This dip also did not act as a certain prophylactic when used as described above. Nor did it cause ticks already feeding to stop. Many experiments were done, the ticks being fed on rabbits, goats, dogs. In one experiment a strength of 1 : 50 was applied to two ticks feeding on a goat and the application was maintained for twenty minutes. At the end of this time both ticks were fast. One moved away after ten minutes further feeding and both were alive and active after twenty-four hours. In some of the experiments the application seemed to disturb the ticks, and they would then walk away.

B. In vitro. Ticks survived very prolonged treatment, two hours with no difficulty and much longer periods. In one experiment, five hours application failed to kill, using a strength of 1 : 50, i.e., twice the strength recommended.

McDougall's sheep dip and cattle dressing. Scab and insect exterminator. One part dip to fifty parts water.

A. Animal experiments. The results were rather variable. Some parasites fed on the treated skin. But in some cases parasites feeding, especially when they had only just commenced to feed, were dislodged, and some of these died within twenty-four hours.

B. In vitro. Ticks survived thirty-two and sixty-four minutes. In one experiment a tick died after two hours immersion, but others survived four and a half and five hours.

Savar's dip. One gallon of dip to seventy gallons of water.

A. Animal experiments. The prophylaxis conferred by this dip did not prove effectual. For example, the skin of a goat was moistened thoroughly with a solution of 1 : 70. Two minutes after, while the skin was still moist, four ticks were placed on it. Of these, two refused to feed, the other two fed well and were apparently none the worse. Again, when the skin had dried, four ticks were placed upon it: these all fed well. In curative experiments ticks were killed in thirty minutes.

B. In vitro. Ticks survived two hours immersion in the solution, but not five hours.

Hayward's Yellow Paste.

A. Animal experiments. The prophylactic action was here again by no means reliable. In the case of feeding ticks this

application was also frequently ineffective. Experiments were done, using the strength 1 : 100 and applying it to feeding ticks on a goat for times varying from sixty seconds to thirty minutes, the parasites surviving such applications. The ticks suffered so little inconvenience that they frequently could be fed again after a short interval. Thus, a tick which had been so treated for thirty minutes while feeding on a rabbit, was removed and after an interval of fifteen hours was able to feed again on a dog.

CONCLUSIONS

1. The dips tested failed very frequently to prevent *Ornithodorus moubata* feeding on an animal.

2. Feeding ticks were not easily caused to loosen their hold by them.

3. In test tube experiments the resistance of this species of tick to these substances in solution is marked.

4. Used in the strength recommended and for the time suggested these dips appear to have very slight effects on this tick.

5. Possibly other ticks behave in a different manner under these applications.